(54) Title: VIRTUAL REALITY NETWORK

(57) Abstract

A virtual reality system has a database for defining one or more three-dimensional virtual spaces. A communication unit establishes a communication between the database and a user, and a data communication unit communicates data from the database to the user so that the user's computer may display a portion of a selected virtual space on the user's head mounted display. The communications unit also receives data corresponding to the position, orientation, and/or movement of the user relative to a reference point and uses the data to define a virtual being within the virtual space, wherein the position, orientation, and/or movements of the virtual being are correlated to the received data. Preferably, the data communicated to the user typically corresponds to the portion of the virtual space viewed from the perspective of the virtual being. The system defines other virtual beings within the database in response to position, orientation, and/or movement data received from other users, and the portions of the virtual space communicated to the other users may correspond to the perspectives of their associated virtual beings. The system periodically updates the database and communicates the updated portions of the database to the users to reflect changes in perspective of the virtual beings and changes in the position of moving objects within the virtual space. The system also supports audio communication with the users. To reduce the amount of data communicated between the computer and each user, visual and sound priority spaces may be defined within the portion of the virtual space data communicated to the user, and elements within selected priority spaces may be updated in priority over other priority spaces.

VIRTUAL REALITY NETWORK

BACKGROUND OF THE INVENTION

5   This invention relates to virtual reality systems and, more particularly, to a virtual reality network wherein multiple users at remote locations may telephone a central communications center and particip: in a virtual reality experience.

10   Virtual reality systems are computer controlled systems which simulate artificial worlds and which allow users to experience and interact with the artificial worlds as if the users actually existed within them. Examples of virtual reality systems and components are disclosed in U.S. Patent

15   Nos. 4,542,291; 4,017,858; 4,945,305; 3,983,474; 4,406,532; 5,003,300; 4,984,179; 4,988,981; and 4,757,714; all of which are incorporated herein by reference. The typical virtual reality system includes a computer, a head-mounted display for displaying an artificial world to the user, and

20   instrumentation for sensing the position and orientation of the user with respect to the computer or some other reference point. The artificial world is defined within the computer's database. Instrumentation data is communicated to the computer, and the computer creates a virtual being within the

25   artificial world which emulates the position, orientation, and movements of the user. The computer then communicates graphical data to the head-mounted display which then displays the artificial world from the perspective of the virtual being. By gesturing in an appropriate manner, the user may

30   interact with virtual objects within the artificial world as if they were real. For example, the user may drive an artificial automobile, throw an artificial ball, etc..

Although virtual reality has proven to be an exciting new technology, it is also a very expensive one. Most virtual

35   reality hardware is located at universities and government agencies, although some virtual reality arcades have been built in major shopping centers located in large cities for playing a few basic games. Still, access to sophisticated

virtual reality systems has been extremely limited and is
often not available to the general public without great
inconvenience.

5   SUMMARY OF THE INVENTION
        The present invention is directed to a virtual reality
system wherein multiple users located at different remote
physical locations may communicate with the system via
conventional dialup telephone lines and may perform
10   independent and/or interactive/collaborative tasks within the
system, aided by inter-user audio communications.
        In one embodiment of the present invention, the virtual
reality system has a central database for defining one or more
three-dimensional virtual spaces. A communication unit
15   establishes a communication between the database and a user,
and a data communication unit communicates data from the
database to the user so that the user's computer may display a
portion of a selected virtual space on the user's head mounted
display. The communications unit also receives data
20   corresponding to the position, orientation, and/or movement of
the user relative to a reference point and uses the data to
define a virtual being within the virtual space, wherein the
position, orientation, and/or movements of the virtual being
are correlated to the received data. Preferably, the data
25   communicated to the user typically corresponds to the portion
of the virtual space viewed from the perspective of the
virtual being.
        The system defines other virtual beings within the
database in response to position, orientation, and/or movement
30   data received from other users, and the portions of the
virtual space communicated to the other users may correspond
to the perspectives of their associated virtual beings. The
system periodically updates the database and communicates the
updated portions of the virtual space to the users to reflect
35   changes in the position of moving objects within the virtual
space. To further reduce the amount of data communicated
between the computer and each user, priority spaces may be
defined within the portion of the virtual space data

communicated to the user, and elements within selected
priority spaces may be updated in priority over other priority
spaces.

The system also supports audio communication with the
users. Sounds may be defined within the virtual space, and
data correlated to the sounds may be communicated to the
users. Additionally, the communications unit may receive
sounds from each user and then communicate the sounds to the
other users to facilitate verbal or other audio communication
among the users. The sounds may be assigned origins within
the virtual space, and a sound control unit may then send data
to each user for simulating the origin of the sound within the
virtual space. The sounds may be assigned to sound priority
spaces so that the amplitudes of sounds assigned to a
particular priority space may be varied relative to the
amplitudes of sounds in other priority spaces.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is diagram of a particular embodiment of a virtual
reality network according to the present invention;

Fig. 2 is a block diagram of a particular embodiment of
the central control unit shown in Fig. 1;

Fig. 3 is a block diagram illustrating how the database
shown in Fig. 2 is partitioned into multiple virtual spaces;

Fig. 4 is a diagram illustrating a particular embodiment
of a virtual space according to the present invention;

Fig. 5 is a diagram illustrating the concepts of visual
relevant spaces and priority spaces within the virtual space;

Fig. 6 is a diagram illustrating the concepts of sound
relevant spaces and sound priority spaces within the virtual
space; and

Fig. 7 is a flowchart showing operation of the virtual
reality network according to the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Fig. 1 is a diagram illustrating a particular embodiment
of a virtual reality network 10 according to the present
invention. Network 10 includes a central control unit 14 for

communicating with a plurality of users, e.g., users 18 and
22, through a public telephone system represented by dialup
telephone lines 26 and 30 coupled to telephones 34 and 38,
respectively. Although telephone lines 26 and 30 have been
5   shown as single lines, each may comprise multiple lines
wherein one or more lines may be used for virtual object or
virtual space data and other lines may be used for audio data.
Furthermore, the present invention is not limited to telephone
communications. Any data transmission network may suffice.
10   For example, network 10 may comprise high speed digital
communication lines, cable broadcasting communication lines,
etc. The number of users supported by network 10 is not
limited to the two shown. Any number of users, even
thousands, may be supported.
15   Typically, user 18 is equipped with a computer 42, a
head-mounted display 46, earphones 50, a microphone 52, a head
position sensor 53, and an instrumented garment 54. User 22
is ordinarily equipped in the same manner. Computer 42 may
include a keyboard 43 for entering control information.
20   Computer 42 may also include a monitor 58 for displaying
control information or the virtual space viewed by user 18,
but it should be understood that the primary display of the
virtual space to user 18 is preferably accomplished by head-
mounted display 46. Alternatively, head-mounted display may
25   be substituted in some applications by a stand-alone display
unit which realistically displays the virtual space to the
user. Earphones 50 receive sounds associated with the
displayed virtual space from central control unit 14 via
computer 42, and microphone 52 communicates sounds from user
30   18 via computer 42 to central control unit 14 which, in turn,
merges the sounds received into the virtual space. Head
position sensor 53 senses the position and/or orientation of
the user's head relative to computer 42 or some other
reference point and communicates the positional data to
35   computer 42 which, in turn, communicates the data to central
control unit 14. Instrumented garment 54 is shown as a glove
in this embodiment, but other instrumented garments such as
shirts, pants, or full-body suits may be used as well.

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Instrumented garment 54 typically senses the position, orientation, and/or flexure of the associated body part relative to computer 42 or some other reference point and communicates the data via computer 42 to central control unit

5   14. Central control unit 14 uses the data from head position sensor 53 and instrumented garment 54 to define a virtual being within the virtual space. The virtual being may take the form of another human being, an animal, machine, tool, inanimate object, etc., all of which may be visible or

10   invisible within the virtual space. The position, orientation, and/or flexure data from the sensors may be used to emulate the same position, orientation, and/or flexure of the defined virtual being, or else the data may be used to control some other action. For example, if the user is

15   defined as a virtual automobile within the virtual space, then position of the user's hand may be used to control acceleration whereas flexure of one or more of the user's fingers may be used to steer the automobile. Additionally, the data may be used to define multiple virtual beings. For

20   example, data from head position sensor 53 may be used to define an aircraft carrier, and data from instrumented garment 54 may be used to define an aircraft.

          Although head-mounted display 46, earphones 50, microphone 52, head position sensor 53 and instrumented glove

25   54 are shown attached to computer 42 through wires, any or all of these elements may be controlled by radio frequency or other wireless technologies.

          In the preferred embodiment, head mounted display 46 displays the portion of the virtual space viewed from the

30   perspective of the virtual being defined for user 18 together with all other defined virtual beings and objects within its field of vision. Each user may talk to and interact with other virtual beings and obje s in the irtual space as the user desires, subject to cons raints not d below when

35   discus g the concepts of relevant spaces.

          F 2 is a block diagram of a particular embodiment of central control unit 14. Central control unit 14 includes a processor 100, a database memory 104 for storing virtual space

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data, an input telephone interface 108 for receiving data from
the users, an output telephone interface 112 for communicating
data to the users, a position/control data receiver 116 for
receiving position, motion and control data from the users, a
5   sound data receiver 120 for receiving sound information from
the users, a position/control data transmitter 124 for
communicating position, motion and control data to the users,
a sound data transmitter 128 for communicating sound data to
the users, a perspective monitor 132 for monitoring the visual
10   perspectives of the virtual beings defined in database 104, a
timer 136, a database update unit 140 for updating database
104 with data received from the users (and other program
controlled changes), a virtual object control unit 144 for
controlling virtual objects defined in database 104, an update
15   communication control unit 148 for controlling the
communication of updated data to the users, and a sound
control unit 152 for processing sound data.

        Data communicated by output telephone interface 112 to
the users may comprise any data defining the virtual space
20   together with the appropriate control information. For
example, the data may comprise graphics data for rendering the
virtual space, position/motion data for implementing moving
objects within the virtual space, sound data, etc.. In the
preferred embodiment, however, graphics data per se is not
25   communicated on an interactive basis. Instead, each user's
computer has a copy of the entire virtual space (e.g.,
background, objects and primitives), and the data defining the
virtual space communicated to the users comprises only
position, motion, control, and sound data. After initial
30   position, motion, control and sound data is communicated to
the users, only changes in the position, motion, control and
sound data is communicated thereafter. This dramatically
reduces bandwidth requirements and allows the system to
operate with many concurrent users without sacrificing real-
35   time realism.

        In the preferred embodiment, database 104 stores data for
multiple virtual spaces. Fig. 3 is a block diagram showing
one possible embodiment of database 104. Database 104 may

contain a CAD virtual space 160 which allows users to engage
in computer aided design, a game virtual space 164 which
allows users to play a game, a task virtual space 168 which
allows users to manipulate virtual objects to perform a
5   particular task, and other virtual spaces. Central control
unit 14 allows the user to interactively communicate with the
virtual space either alone or in collaboration with other
users. Each virtual space includes identification information
170, 172, 174, etc. so that users may specify which virtual
10   space they intend to interact with.
          Fig. 4 is a diagram of a particular embodiment of a
virtual space 169. Virtual space 169 may include a plurality
of virtual beings such as virtual beings 182, 183, and 184,
sound origins 186, 188, 190, and 192, a movable virtual object
15   194, other virtual objects 196, 197 and 198, and graphics
primitives 199A-F. Graphics primitives 199A-F may be used by
any user to create further virtual objects if desired. To
provide maximum flexibility and to facilitate communication
with the users, each virtual being, and hence each user, is
20   assigned a visual relevant space which determines which data
defining the virtual space may be perceived by the user. In
the context of the preferred embodiment, visual relevant
spaces determine which state changes are communicated to (or
perceivable by) the users. Of course, in other embodiments
25   the visual relevant space may include all the graphical
information encompassed by the boundaries of the visual
relevant space. Fig. 5 is a diagram showing how the concepts
of visual relevant spaces are applied to virtual beings 182
and 184 of Fig. 4. Virtual being 182 is assigned a visual
30   relevant space 200, and virtual being 184 is assigned a visual
relevant space 204. Virtual beings 182 and 184 may view only
those elements (objects or states changes) which are disposed
within their visual relevant spaces. For example, elements
194 and 196 and/or their motion may be visible to both virtual
35   beings 182 and 184; element 197 and/or its motion may be
visible only to virtual being 184; element 183 and/or its
motion may be visible only to virtual being 182, and element
198 and/or its motion may be visible to neither virtual,

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motion being 182 nor virtual being 184. In the preferred
embodiment which communicates only position, control and sound
data to the users, those elements outside of a visual relevant
space may be visible to the user, but any real-time or program
5   controlled position/motion associated with the element is not
processed for that user so that the element appears stationary
in a fixed position, or else the element moves in accordance
with a fixed script. The visual relevant space may be fixed
as shown for virtual being 182. Alternatively, the user's
10   visual relevant space may be defined by the field of view of
the virtual being and areas in close proximity to it (as with
virtual being 184), in which case the visual relevant space
may move about the virtual space as the perspective or
position of the virtual being changes. Visual relevant spaces
15   need not be contiguous and need not have a direct spatial
relationship to the virtual space. For example, a visual
relevant space may include a virtual object without the
accompanying background.

        Each visual relevant space may be further subdivided into
20   one or more visual priority spaces. For example, visual
relevant space 200 may include visual priority spaces 206,
208, and 210, and visual relevant space 204 may include visual
priority spaces 212, 214, and 216. In the preferred
embodiment, visual priority spaces may be used to determine
25   the update frequency of elements located within them. For
example, the position and orientation of elements 183, 194 and
196 may be updated very frequently (e.g., at 30 Hz), whereas
the position and orientation of element 197 may be updated
less frequently (e.g., at 1 Hz). Alternatively, visual
30   priority spaces closer to the user may be updated more
frequently than other visual priority spaces. This reduces
the amount of data that must be communicated to each user
while maintaining realism of important elements. Since many
virtual objects are designed to move about the virtual space,
35   they may cross into different priority spaces over time and be
processed accordingly. The change from one priority space to
another may be continuous or discrete as desired.

Relevant spaces also may be defined for sound data. Fig.
6 is a diagram illustrating the concept of sound relevant
spaces. Virtual being 182 has a sound relevant space 230
associated with it, and virtual being 184 has a sound relevant
5   space 234 (indicated by a dashed line) associated with it.
Only sound sources disposed within a virtual being's sound
relevant space (and/or changes in the sounds) may be perceived
by that being, and hence the corresponding user. In this
case, sound sources 186, 188, 190, and 192 and/or their
10   changes may be perceived by both virtual beings 182 and 184.
It should be noted that sound sources associated with an
element which cannot be visually perceived by a virtual being
may nevertheless be heard by the virtual being. Such may be
the case with element 183 associated with sound source 192.
15   If so, while only virtual being 182 may see the element, both
virtual beings 182 and 184 may hear it. It should also be
noted that sound relevant spaces, like visual relevant spaces,
need not be contiguous and need not have a direct spatial
relationship to the virtual space.
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Sound priority spaces may also be defined for each sound
relevant space. As shown in Fig. 6, sound relevant space 230
includes sound priority spaces 238, 242, and 246, and sound
relevant space 234 includes sound priority spaces 252, 256,
25   and 260. In this embodiment, the amplitude of the sound
source perceived by the virtual being depends upon which sound
priority space the sound source is located. Thus, virtual
being 182 may perceive sound source 186 louder than sound
source 190, and sound source 190 louder than sound sources 188
30   and 192. Similarly, virtual being 184 may perceive sound
source 188 louder than sound sources 186 and 190, and sound
source 186 and 190 louder than sound source 192. Sound
priority spaces also may be defined to set the update
frequency of the sound data. Since sound origins may move
35   along with virtual objects to which they are attached, a given
sound may cross into different sound priority spaces over time
and be processed accordingly. The change from one sound

priority space to another may be continuous or discrete as
desired.

Input telephone interface unit 108 (Fig. 2) receives
input data from the users through the telephone network and
5   communicates control data and positional data such as that
from the users' head position sensors and instrumented
garments (e.g., position, orientation and/or movement) to
position/control data receiver 116 through a communication
path 156. Sound data received from the users (e.g., from
10   their microphones) is communicated to sound data receiver 120
through a communication path 160. . Position/control data
receiver 116 and sound data receiver 120 communicate with
processor 100 through communication paths 161 and 163,
respectively. Processor 100 maps the position, orientation
15   and/or movement data from each user to corresponding virtual
beings within the requested virtual space in database 104.
Control data received from the users may be used to establish
the telephonic communication with central control unit 14, to
specify a desired virtual space, to specify the type of
20   virtual being the user wishes to assume, and possibly how the
positional data is to be mapped to the selected virtual being,
to create virtual objects (using graphics primitives 199A-F),
to specify visual and sound relevant spaces and their
corresponding priority spaces, etc. Sound data received from
25   the users may be associated with the virtual beings defined
for those users or assigned in some other manner. For
example, sound data from one of the users may be assigned to a
virtual public address system for announcing the beginning of
a race in which that user and other users compete.
30   Processor 100 updates database 104 with the received
position, motion, control, and sound data, determines which
user is to receive which data according to the relevant and
priority spaces defined for that user, communicates position,
motion and control information to position/control data
35   transmitter 124 through a communication path 162, and
communicates sound data to sound data transmitter 128 through
a communication path 164. Position/control data transmitter
124 and sound data transmitter 128 communicate with output

telephone interface 112 through respective communication paths
168 and 172 for sending the data to the users.

Perspective monitor 132 monitors the defined field of
view of each virtual being to determine the visual state
5   change data to be communicated to the users. As noted above,
in the preferred embodiment, each user has a copy of the
selected virtual space in his or her computer, and processor
100 periodically sends only the positional and sound data
assigned to points within the user's relevant space or field
10   of view to the user so that the user's computer may update the
images viewed and sounds heard with the new positional and
sound data. To further reduce the amount of data communicated
to the users, which updated data is sent to the user at a
particular time may be determined by the priority space in
15   which the object or sound is located. Thus, data for updating
objects or sounds in one priority space may be communicated
thirty times per second, whereas data for updating objects or
sounds in another priority space may be communicated once per
second.
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In another embodiment of the invention, processor 100 may
communicate all graphical data associated with the relevant
space or field of view of the virtual being to the
corresponding user and then instruct update communication
25   control unit 148 to send updated data as appropriate. For
example, processor 100 may use the positional data from the
user's head position sensor to determine the position of the
head of the virtual being defined for that user and
communicate the graphical data for that portion of the
30   relevant space to the user. As the user moves about,
processor 100 receives new positional data, and database
update unit 140 uses that data to update the position (and
hence the field of view) of the corresponding virtual being in
database 104. Perspective monitor detects the occurrence of a
35   selected event and then instructs update communication control
unit 148 to communicate the graphical data for the updated
field of view to the user. The event which triggers the
communication of the updated data to the users may be the

passage of a selected time interval measured by timer 136. Alternatively, perspective monitor 132 may instruct update communication control unit 148 to send the updated data when the position of the user's head changes by a selected amount,

5   or it may rely upon the occurrence of some other variance in the data received from the user.

        Virtual object control unit 144 defines or maintains the virtual objects within database 104 and assigns the position, orientation, and/or movement data received from the user to

10   the virtual objects. For example, data designating flexure and position of the user's legs, arms, fingers, etc. may be assigned to the virtual being's legs, arms, fingers, etc. so that the virtual being may emulate the gestures of the user for running, kicking, catching virtual balls, painting,

15   writing, etc.. Of course, as noted above, the virtual being defined or maintained by virtual object control unit 144 need not be humanoid and it may be specified by the user using primitives 199A-F in any desired combination. The position, orientation, and/or movement data received from a user may be

20   assigned to one or more visible or invisible objects as the imagination allows. Virtual object control unit 144 also may define or maintain program-generated and controlled virtual objects within the virtual space. For example, virtual object control unit 144 may define or maintain a virtual volley ball

25   or a virtual satellite which moves in accordance with program-defined constraints such as range of motion, speed, gravitational forces, etc..

        Sound control unit 152 defines the origin and nature of sounds within the virtual space and assigns the sound data

30   received from the users to them. The simplest example of the assignment of sounds is the assignment of a user's voice to the voice of the corresponding virtual being. The voice of the virtual being may track the user's voice exactly, or else sound control unit 152 may vary the pitch or timbre of the

35   voice accordingly. The user's voice also could be changed to emulate the chosen virtual being. For example, the user's voice could be changed to emulate a frog or jet aircraft, with the amplitude of the user's voice being used to control the

amplitude of the virtual sound. Sound control unit 152 also
may assign program-defined sounds to the virtual space. For
example, sound control unit may generate the sound
accompanying a program-generated aircraft randomly passing
5   through the virtual space. Sound control unit also controls
the characteristics (e.g., amplitude, update frequency, etc.)
of the virtual sounds according to the sound priority spaces
in which the sounds are located.

Finally, sound control unit 152 also may control the
10   perceived spatial positioning of the sound within the virtual
space. The user transmits to central control unit 14
monophonic speech which is processed by an mixer within sound
control unit 152. The mixer combines all the sounds received
by the various users and transmits the sounds located within a
15   user's sound relevant space to that user. Amplitude may be
determined by the sound priority space in which the sound
origin is located and/or based on how loud a user is talking
(or some other dynamically alterable rule). The data
communicated by sound data transmitter 128 may include data to
20   direct the user's hardware to pan, in real time, the incoming
monophonic signal across its stereo outputs, thus creating the
illusion of stereo audio to enhance the sensation of immersion
within the virtual space without increasing communications
bandwidth requirements between the user and the system.
25   Operation of one embodiment of the system is illustrated
in figure 7. The user initially logs on to central control
unit 14 in a step 300 using a conventional modem and serial
line concentrator coupled to a telephone line which functions
as a data line. The user's computer transmits identification
30   codes along the data line to begin the logon sequence. Once
the data line connection has been established, the user's
computer establishes a second connection with the system,
using a second telephone line, to establish the audio
connection in a step 304. This is done by transmitting a
35   unique series of DTMF codes along the second telephone line to
central control unit 14 to inform central control unit 14
which audio line is to be correlated to which data line. This
is important, since the incoming lines to central control unit

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14 most likely originate from a telephone company rotary
switch, and without the DTMF identifiers the system would not
know which audio line corresponds to which data line. Once
the second connection is established, the user connection to

5   the system is complete.

Once the connection is established, the user transmits
data to central control unit 14 to select which virtual space
the user desires to interact with in a step 308. This data
also may include mapping information specifying virtual

10   objects within the virtual space and how the position, motion,
and sound data is to be mapped within the selected virtual
space. The data also may include relevant and priority space
information as well as information which enables central
control unit 14 to create virtual objects from graphical

15   primitives. Central control unit 14 then establishes the
user, relevant spaces, priority spaces and any specified
virtual objects within the virtual space in a step 310. At
the same time central control unit 14 searches for other users
in the same universe. If other users are found, central

20   control unit 14 calculates the proximity of the other users
(and their defined virtual objects) based on XYZ coordinate
differentials. Once the coordinate differentials are
calculated, locations of the other users and their defined
virtual objects within and without the relevant and priority

25   spaces may be determined and used to ascertain which position,
motion and sound data is transmitted to which user in a step
314. In this manner position, motion and sound data is not
transmitted to users that would not be able to use that data
at that point in time.

30   It is then ascertained in a step 318 whether the session
is to be terminated. If so, the user is logged off the system
in a step 322. If not, central control unit 14 continues to
receive position, motion, and sound data (together with any
other commands) from the various users in a step 326, updates

35   the virtual space in a step 330, calculates coordinates and
processes the data in the various relevant spaces in a step
334, processes the data in the various priority spaces in a
step 338, communicates the updated state data to the various

users in a step 342 (based on the relevant and priority spaces for each user), and continues in step 318.

While the above is a detailed description of a preferred embodiment of the present invention, various modifications may

5   be employed. Consequently, the scope of the invention should be ascertained by the following claims.

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WHAT IS CLAIMED IS:

1. An apparatus for allowing users to interact with a
virtual space comprising:

a database defining a three-dimensional virtual space;

5   communication means for establishing a communication
between the database and a first user; and

data communicating means for communicating data from the
database to the first user, wherein the communicated data
comprises data defining the virtual space.

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2. The apparatus according to claim 1 further
comprising:

first receiving means for receiving first data
corresponding to a position of the first user at a first time;

15   first being defining means for defining a first virtual
being within the virtual space, the first virtual being having
a position within the virtual space correlated to the first
data; and

wherein the data communicating means includes first
20 perspective communicating means for communicating data to the
first user corresponding to a portion of the virtual space
viewed from the perspective of the first virtual being
associated with to the first data.

25   3. The apparatus according to claim 2 further
comprising:

second receiving means for receiving second data
corresponding to position of the first user at a second time;
and

30   first updating means for updating the database so that
the first virtual being has a position within the virtual
space correlated to the second data.

35   4. The apparatus according to claim 3 wherein the data
communicating means includes first update communicating means
for communicating, to the first user, updated data
corresponding to a portion of the virtual space viewed from

the perspective of the first virtual being in response to a first event.

5.   The apparatus according to claim 4 wherein the first event is the passage of a selected time interval.

6.   The apparatus according to claim 4 further comprising:
perspective monitoring means for detecting when the first data varies from the second data by a selected amount;   and
wherein the first update communicating means communicates the updated data to the first user when the first data varies from the second data by the selected amount.

7.   The apparatus according to claim 4 further comprising:
virtual object means for defining a movable first virtual object within the virtual space;   and
object manipulating means for allowing the first virtual being to manipulate the first virtual object

8.   The apparatus according to claim 4 wherein the communication means includes means for establishing a communication between the database and a second user, and wherein the data communicating means includes means for communicating data from the database to the second user, wherein the communicated data corresponds to a second portion of the virtual space.

9.   The apparatus according to claim 8 further comprising:
third receiving means for receiving third data corresponding to a position of the second user at a third time;
second being defining means for defining a second virtual being within the virtual space, the second virtual being having a position within the virtual space correlated to the third data;   and

wherein the data communicating means includes second
perspective communicating means for communicating data to the
second user corresponding to a portion of the virtual space
viewed from the perspective of the second virtual being
5   associated with the third data.

10.   The apparatus according to claim 9 further
comprising:
      fourth receiving means for receiving fourth data
10   corresponding to a position of the second user at a fourth
time;   and
      second updating means for updating the database so that
the second virtual being has a position within the virtual
space correlated to the fourth data.
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11.   The apparatus according to claim 10 wherein the data
communicating means includes second update communicating means
for communicating, to the second user, updated data
corresponding to a portion of the virtual space viewed from
20   the perspective of the second virtual being in response to a
second event.

12.   The apparatus according to claim 11 further
comprising:
25   virtual object means for defining a movable first virtual
object within the virtual space;   and
      object manipulating means for allowing the first and
second virtual beings to manipulate the first virtual object.

30   13.   The apparatus according to claim 1 wherein the
communication means includes means for establishing a
communication between the database and a second user, and
wherein the data communicating means includes means for
communicating data from the database to the second user,
35   wherein the communicated data corresponds to a second portion
of the virtual space.

14.   The apparatus according to claim 1 further
comprising:

virtual sound means for defining a virtual sound within
the virtual space;   and

5   wherein the data communicating means further comprises
virtual sound communicating means for communicating, to the
first user, data correlated to the virtual sound.

15.   The apparatus according to claim 1 wherein the
10   database defines a plurality of virtual spaces, wherein the
apparatus further comprises identification receiving means for
receiving identifying data for identifying one of the
plurality of virtual spaces, and wherein the data communicated
by the data communicating means corresponds to the identified
15   virtual space.

16.   The apparatus according to claim 1 further
comprising first relevant space defining means for defining a
first relevant space corresponding to the first user in the
20   virtual space, and wherein the data communicated to the first
user corresponds to the portion of the virtual space only
within the relevant space.

17.   The apparatus according to claim 16 further
25   comprising:
.first receiving means for receiving first data
corresponding to a position of the first user at a first time;
first being defining means for defining a first virtual
being within the virtual space, the first virtual being having
30   a position within the virtual space correlated to the first
data;   and
wherein the first relevant space is defined relative to
the first virtual being.

35   18.   The apparatus according to claim 17 wherein the
first relevant space is defined by a portion of the virtual
space viewed from the perspective of the first virtual being
associated with the first data and portions of the virtual

space in close proximity thereto, so that the data
communicating means communicates data to the first user
corresponding to a portion of the virtual space viewed from
the perspective of the first virtual being.

5

     19. The apparatus according to claim 18 further
comprising:
     second receiving means for receiving second data
corresponding to position of the first user at a second time;

10   and
     first updating means for updating the database so that
the first virtual being has a position within the virtual
space correlated to the second data.

15   20. The apparatus according to claim 19 wherein the data
communicating means includes first update communicating means
for communicating, to the first user, updated data
corresponding to a portion of the virtual space viewed from
the perspective of the first virtual being in response to a

20   first event.

     21. The apparatus according to claim 20 wherein the
first event is the passage of a time interval.

25   22. The apparatus according to claim 20 further
comprising:
     perspective monitoring means for detecting when the first
data varies from the second data by a selected amount; and
     wherein the first update communicating means communicates

30   the updated data to the first user when the first data varies
from the second data by the selected amount.

     23. The apparatus according to claim 20 further
comprising:

35   virtual sound means for defining a virtual sound within
the virtual space; and

wherein the data communicating means further comprises
virtual sound communicating means for communicating, to the
first user, data correlated to the virtual sound.

5   24. The apparatus according to claim 23 wherein the
virtual sound means includes origin assigning means for
assigning a sound origin to the virtual sound within the
virtual space, and wherein the sound communicating means
communicates the data correlated to the virtual sound to the
10   first user only if the sound origin is located within the
relevant space.

          25. The apparatus according to claim 20 wherein the
first relevant space includes a plurality of first priority
15   spaces, and wherein the first update communicating means
includes first priority communicating means for communicating
updated data corresponding to elements in one of the first
priority spaces in priority over updated data corresponding to
elements within other first priority spaces.
20

          26. The apparatus according to claim 20 wherein the
database defines a plurality of virtual spaces, wherein the
apparatus further comprises identification receiving means for
receiving identifying data for identifying one of the
25   plurality of virtual spaces, and wherein the data communicated
by the data communicating means corresponds to the identified
virtual space.

          27. The apparatus according to claim 20 further
30   comprising:
          virtual object means for defining a movable first virtual
object within the virtual space; and
          object manipulating means for allowing the first virtual
being to manipulate the first virtual object.
35

          28. The apparatus according to claim 20 wherein the
communication means includes means for establishing a
communication between the database and a second user, and

wherein the data communicating means includes means for
communicating data from the database to the second user,
wherein the communicated data corresponds to a second portion
of the virtual space.

5

29. The apparatus according to claim 28 further
comprising second relevant space defining means for defining a
second relevant space corresponding to the second user in the
virtual space, and wherein the data communicated to the second
10   user corresponds to the portion of the virtual space only
within the second relevant space.

30. The apparatus according to claim 29 further
comprising:
15   third receiving means for receiving third data
corresponding to position of the second user at a third time;
          second being defining means for defining a second virtual
being within the virtual space, the second virtual being
having a position within the virtual space correlated to the
20   third data; and
          wherein the second relevant space is defined relative to
the second virtual being.

31. The apparatus according to claim 30 wherein the
25   second relevant space is defined by a portion of the virtual
space viewed from the perspective of the second virtual being
associated with the third data and portions of the virtual
space in close proximity thereto, so that the data
communicating means communicates data to the second user
30   corresponding to a portion of the virtual space viewed from
the perspective of the second virtual being.

32. The apparatus according to claim 31 wherein the data
communicating means includes second update communicating means
35   for communicating, to the second user updated data
corresponding to the portion of the virtual space viewed from
the perspective of the second virtual being in response to a
second event.

33.   The apparatus according to claim 32 further
comprising:
        virtual sound means for defining a virtual sound within
the virtual space;   and
5   wherein the data communicating means further comprises
virtual sound communicating means for communicating, to the
first and second users, data correlated to the first virtual
sound.

10   34.   The apparatus according to claim 33 wherein the
virtual sound means includes origin assigning means for
assigning a sound origin to the virtual sound within the
virtual space, wherein the virtual sound communicating means
communicates the data correlated to the virtual sound to the
15   first user only if the sound origin is located within the
first relevant space, and wherein the virtual sound
communicating means communicates the data correlated to the
virtual sound to the second user only if the sound origin is
located within the second relevant space.
20

35.   The apparatus according to claim 32 wherein the
first relevant space includes a plurality of first priority
spaces, and wherein the first update communicating means
includes first priority communicating means for communicating
25   updated data to the first user corresponding to elements
within one of the first priority spaces in priority over
updated data corresponding to elements within other first
priority boundaries.

30   36.   The apparatus according to claim 35 wherein the
second relevant space includes a plurality of second priority
spaces, and wherein the second update communicating means
communicates updated data to the second user corresponding to
elements within one of the second priority spaces in priority
35   over updated data corresponding to elements within other
second priority boundaries.

37.   The apparatus according to claim 32 wherein the database defines a plurality of virtual spaces, wherein the apparatus further comprises identification receiving means for receiving, through the telephonic communication, identifying

5   data from the first and second users for identifying one of the plurality of virtual spaces, and wherein the data communicated by the data communicating means to the first and second users corresponds to the identified virtual space.

10   38.   The apparatus according to claim 32 further comprising:
        virtual object means for defining a movable first virtual object within the virtual space;   and
        object manipulating means for allowing the first and
15   second virtual beings to manipulate the first virtual object.

        39.   The apparatus according to claim 32 further comprising:
        first sound receiving means for receiving data
20   corresponding to a first sound from the first user;
        first sound origin assigning means for assigning a first sound origin to the data corresponding to the first sound within the virtual space;
        second sound receiving means for receiving data
25   corresponding to a second sound from the second user;
        second sound origin assigning means for assigning a second sound origin to the data corresponding to the second sound within the virtual space;
        first sound relevant space defining means for defining a
30   first sound relevant space in the virtual space corresponding to the first virtual being;
        second sound relevant space defining means for defining a second sound relevant space in the virtual space corresponding to the second virtual being;
35   wherein the data communicating means further comprises first sound communicating means for communicating, to the first user, data correlated to sounds having their origin only within the first sound relevant space;   and

wherein the data communicating means further comprises
second sound communicating means for communicating, to the
second user, data correlated to sounds having their origin
only within the second sound relevant space.

40. The apparatus according to claim 39 wherein the
first sound communicating means further comprises first sound
position emulating means for communicating, to the first user,
data for emulating the spatial origin of sounds within the
first sound relevant space.

41. The apparatus according to claim 40 wherein the
second sound communicating means further comprises second
sound position emulating means for communicating, to the
second user, data for emulating the spatial origin of sounds
within the second sound relevant space.

42. The apparatus according to claim 39 wherein the
first sound relevant space includes a plurality of first sound
priority spaces, and wherein the first sound communicating
means includes first amplitude varying means for
communicating, to the first user, data for varying the
amplitude of sounds within the first sound relevant space
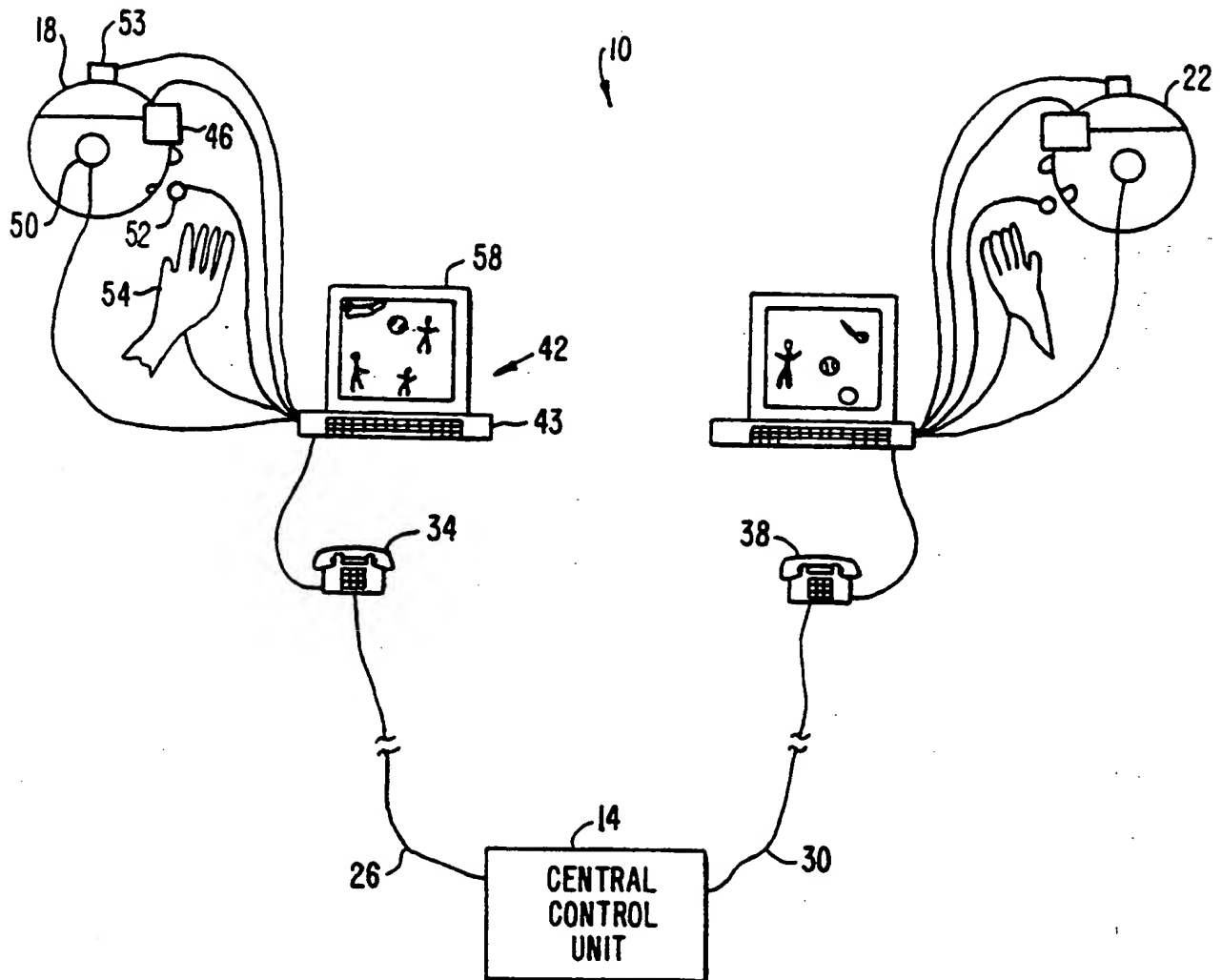depending upon in which sound priority space the sounds have
their origin.

43. The apparatus according to claim 42 wherein the
second sound relevant space includes a plurality of second
sound priority spaces, and wherein the second sound
communicating means includes second amplitude varying means
for communicating, to the second user, data for varying the
amplitude of sounds within the second sound relevant space
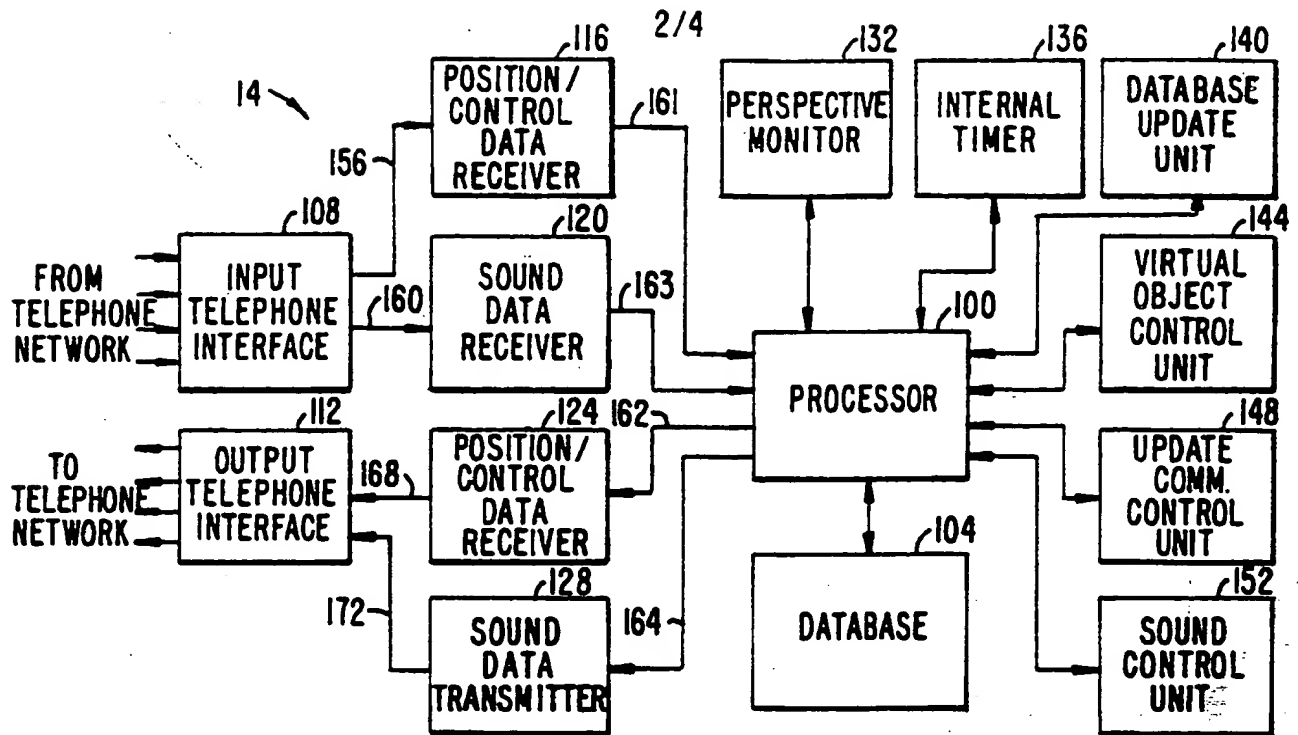depending upon in which sound priority space the sounds have
their origin.

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FIG. I.

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FIG. 2.

FIG. 3.

FIG. 4.

SUBSTITUTE SHEET

VISUAL RELEVANT
SPACES AND PRIORITY
SPACES

FIG. 5.

SOUND RELEVANT SPACES
AND PRIORITY SPACES
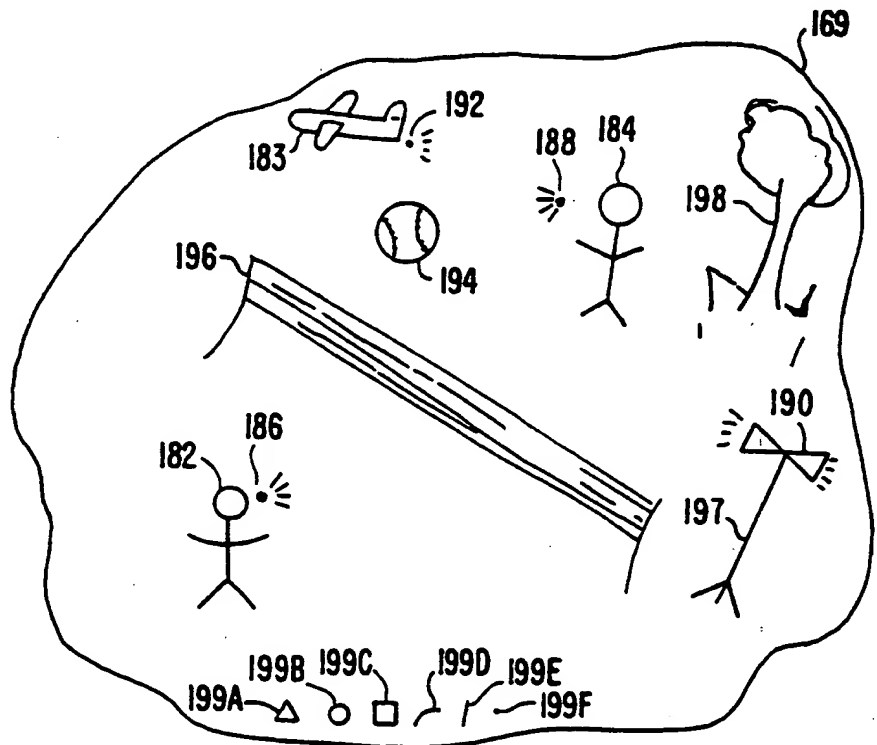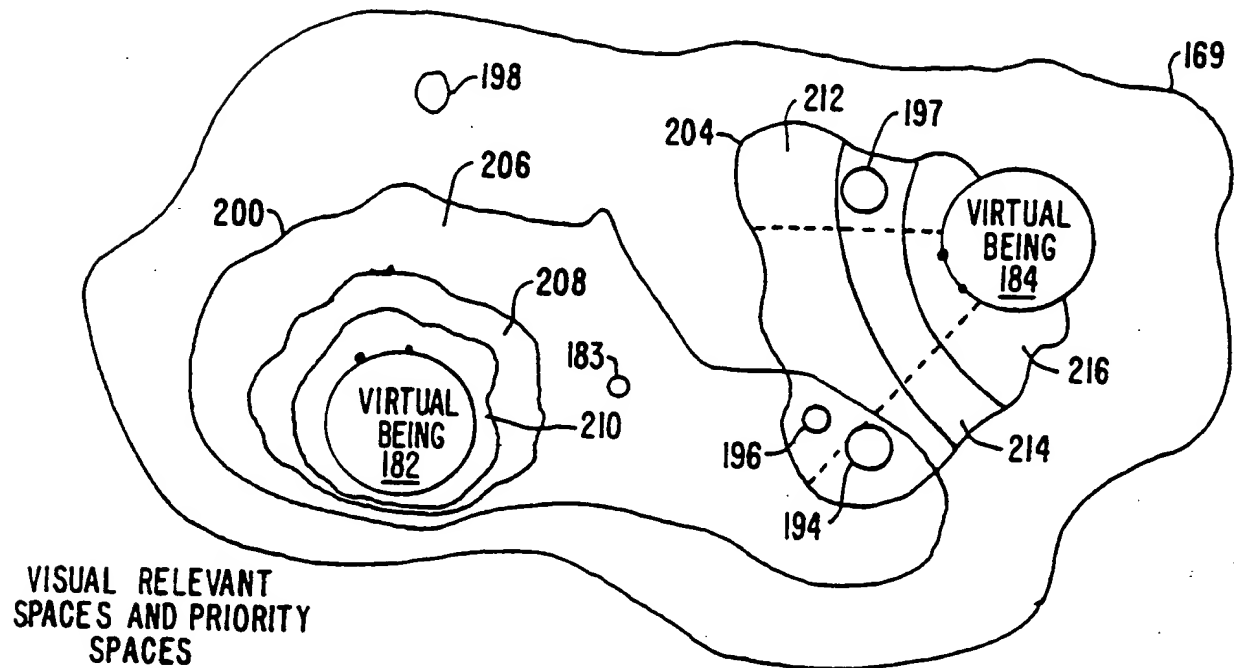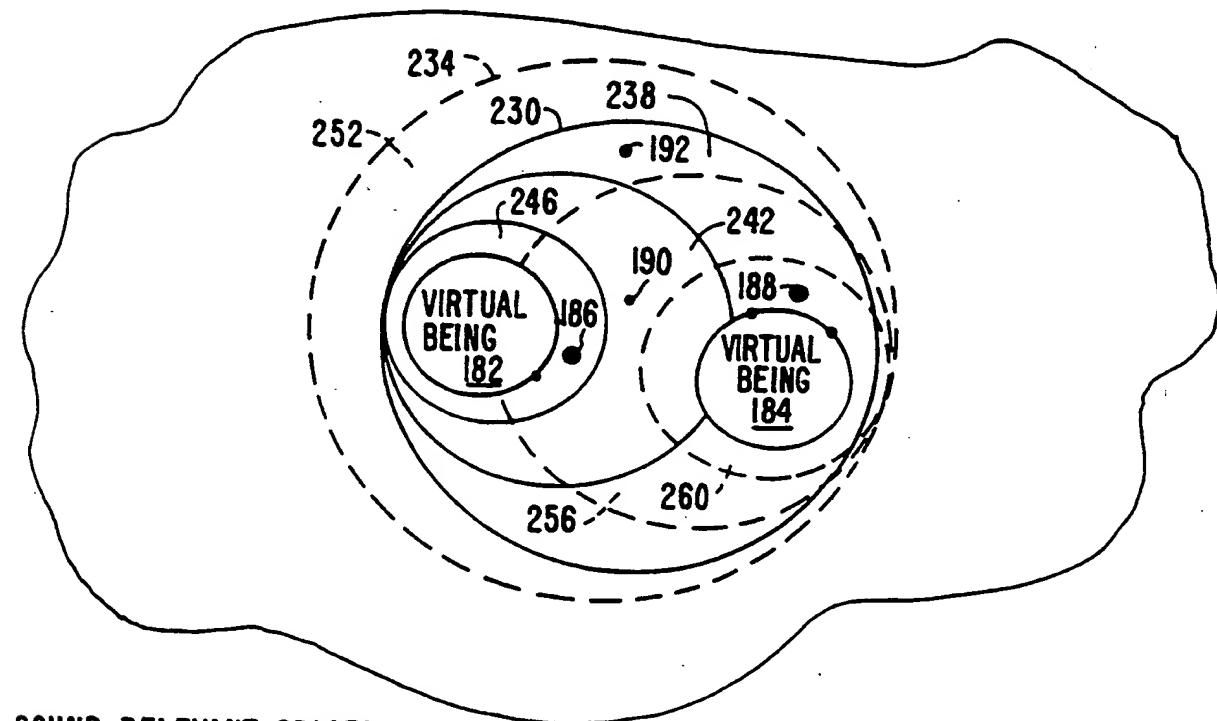
FIG. 6.

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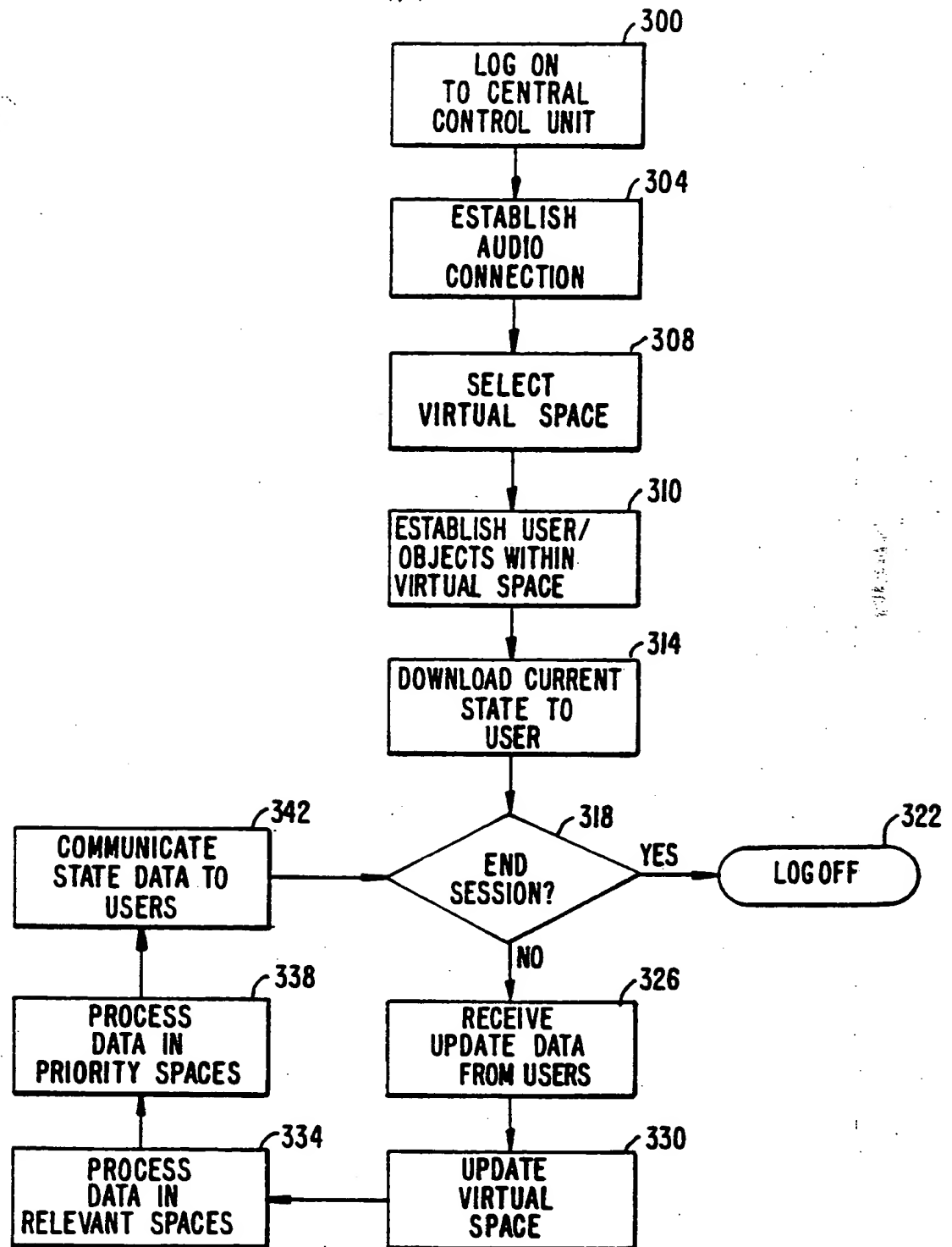
FIG. 7.

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INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6   G06F3/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 6   G06F   G09B   A63F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CHI'92 CONDFRERENCE PROCEEDINGS , ACM CONFERENCE ON HUNMAN FACTORS IN COMPUTING SYSTEMS May 1992 , MONTEREY, CA pages 329 - 334 XP426815 CODELLA C. AT AL 'Interactive Simulation in a Multi-Person Virtual World' see the whole document	1-4,8, 10-13, 16-20, 27,28
Y	---	15
Y	EP,A,0 479 422 (HUGHES AIRCRAFT COMPANY) 8 April 1992 see page 4, line 3 - line 8 ---	15
	-/--	

[X] Further documents are listed in the continuation of box C.   [X] Patent family members are listed in annex.

* Special categories of cited documents :

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
4 January 1995	1 7. 01. 95

Name and mailing address of the ISA	Authorized officer
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page 1 of 2

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	MACHINE DESIGN vol. 62, no. 24 , November 1990 , CLEVELAND US pages 40 - 41 XP176519 '3D SOUND POINTS PILOTS TOWARDS THE ENEMY' see the whole document ---	23,24, 33,34, 39-41
A	PROCEEDINGS 1990 SYMPOSIUM ON INTERACTIVE 3D GRAPHICS March 1990 , UTAH, USA pages 35 - 36 BLANCARD C. ET AL 'Reality Built For Two : A Virtual Reality Tool' ---	1-15
P,X	WO,A,94 17860 (CYBERGEAR) 18 August 1994 see page 3, line 1 - page 4, line 30 see page 5, line 19 - line 25 see page 11, line 9 - line 22 see page 12, line 16 - page 13, line 7 see page 17, line 18 - page 21, line 6; figure 8 -----	1-5, 7-19, 21-23, 26-33,37

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP-A-0479422	08-04-92	NONE	
WO-A-9417860	18-08-94	NONE	